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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 4 : H04N 7/08, 13/00, 13/02 H04N 13/04	A1	(11) International Publication Number: WO 88/ 01464 (43) International Publication Date: 25 February 1988 (25.02.88)

(21) International Application Number: PCT/AU87/00273

(22) International Filing Date: 18 August 1987 (18.08.87)

(31) Priority Application Number: PH 7535

(32) Priority Date: 19 August 1986 (19.08.86)

(33) Priority Country: AU

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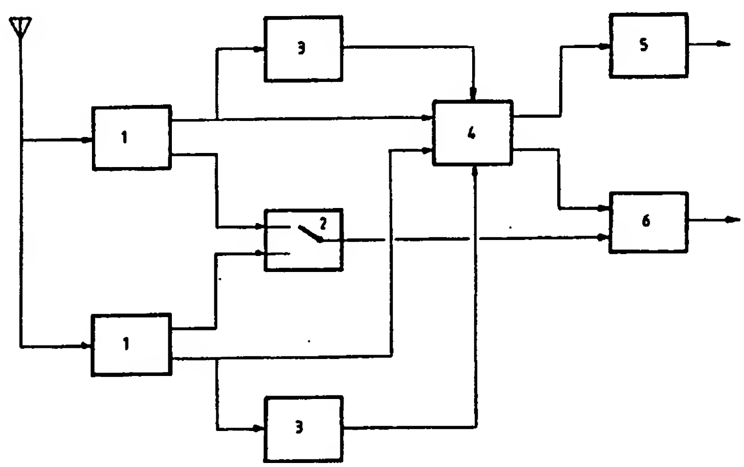
(81) Designated States: AT (European patent), AU, BE (European patent), BR, CH, CH (European patent), DE, DE (European patent), DK, FI, FR (European patent), GB, GB (European patent), IT (European patent), JP, KR, LU, LU (European patent), NL, NL (European patent), NO, SE, SE (European patent).

Published
With international search report.

(54) Title: TELEVISION RECEPTION AND TRANSMISSION FOR ENHANCED IMAGE DISPLAY



(57) Abstract

A television transmitting and receiving system can provide enhanced image display such as stereoscopic images or high resolution images. The system has a transmitting means which simultaneously transmits two television channels - one having standard television signals and the other having information concerning the enhanced image. Thus, the system is fully compatible with existing television receivers albeit that the existing television receivers will not be able to provide the enhanced image. A receiver has channel receiving circuits (1 and 1). The field identity of the video signal in each channel is selected by field detector circuits (3 and 3) from signals impressed in the blanking periods. The video signals are then passed to field selector circuit (4) which provides a composite video signal output having only the same fields (either always "odd" or always "even") but alternating the one channel and then the other channel (for stereoscopic television). In other words the field selector circuit (4) (in the case of stereoscopic television) selects right eye image and then left eye image. A control circuit (5) operates means to permit the viewer's eyes to see the required right eye image and the left eye image. The video signals from the selector circuit (4) and an audio signal from selector switch (2) are recombined in a modulator circuit (6) and sent to the input end of a normal television receiver. A transmitter for the above purpose is disclosed. A video camera having a binocular lens system is described.

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TELEVISION RECEPTION AND TRANSMISSION FOR ENHANCED IMAGE DISPLAY

Field of the Invention

This invention relates to a television transmitting and receiving system which provides enhanced image display while maintaining compatibility with existing broadcasting and receiving systems. One example of enhanced image display is high resolution television and another example is stereoscopic television.

Description of the Prior Art

Many attempts have been made to improve conventional television services by including additional features such as stereoscopic viewing, images with higher resolution, pictures with different aspect ratio and the like. Although these additional features work well with matching transmitters and receivers, conventional receivers are not only unable to make use of the additional feature(s), they cannot display a picture with normal quality if the transmitter adopts these new formats. It is an object of this invention to overcome this problem of incompatibility such that conventional receivers can still be used to receive and display programmes transmitted in formats conforming to the invented system, whilst receivers based on the invented system can also display programmes transmitted in standard formats. An analogy is the reception of colour television transmission by a black and white receiver and reception of black and white television transmission by a colour television receiver.

A conventional television picture is displayed on a cathode ray tube (CRT) using a method called raster scan. This method entails building up the picture by scanning the screen, line by line with an electron beam. This scanning is controlled electronically by the line timebase producing a linear left to right sweep, and the field timebase producing a linear top to bottom sweep. Each line takes approximately 64 microseconds (depending on the standards used) to scan, and a field, of approximately 300 lines (again depends on the standards used), takes either 20 msec or 16.67 msec. A second field is interlaced with the first to provide a completed frame. In Australia, each field consists of 312.5 lines and a frame consists of 625 lines.

Since the frame is formed by 2 interlaced fields, one field may be identified as the odd field, which consists of all the odd-numbered lines, and the other as the even field which consists of all the even-numbered lines. The interlacing is done to reduce the picture flicker without increasing the bandwidth of the transmitted signal. Not all

lines in a frame are available to carry video signals. Approximately 20 lines per field are needed to allow for the blanking period, that is when the electron beam moves from bottom to top of the cathode ray tube. These spare lines can be used to carry various extra signals. In fact some of these lines are already used for carrying signals such as insertion test signals for checking television performance, and Teletext for information services. Standard circuits have been developed to generate and detect these signals.

Summary of the Invention

The invented method and system involves the transmission of a principal channel which conforms to conventional television standards and one or more auxiliary channels for the additional information. Throughout the description and claims the term "channel" is to be understood in the broadest sense to refer to a band of frequencies or a specified path for the transmission and reception of signals. It includes conventional television broadcasting channels in the VHF and UHF bands as well as the signal paths employed in satellite T.V. and cable T.V.. Identification and timing signals may be embedded in either the principal channel and/or the auxiliary channel for signal processing by the receiver or by other predetermined methods if these identification signals are not available.

According to one aspect of the present invention there is provided a television transmitting and receiving system for providing enhanced image display, the system comprising:

transmitting means for transmitting a first television signal over a principal channel and a second television signal over an auxiliary channel;

receiving means for receiving said first and said second television signals;

converting means for converting the received said first and said second television signals to obtain a composite video signal and for supplying said composite video signal to a display means; and

wherein, in use, said principal channel conforms to conventional television standards and at least the first of said first and second television signals is compatible with conventional television receivers,

whereby enhanced image display can be obtained using additional information contained in the second television signal,

According to another aspect of the present invention there is provided a method of transmitting and receiving television signals to provide an enhanced image for display comprising:

transmitting a first television signal via a principal channel;

transmitting a second television signal via an auxiliary channel;

said first television signal being a standard television signal which can be received and displayed by a compatible television receiver;

said second television signal containing additional information to provide the enhanced image;

receiving said first and said second television signals; and

providing an enhanced image display.

According to a further aspect of the present invention there is provided apparatus for converting first and second video signals corresponding respectively to the left eye and right eye images of a received stereoscopic image pair into a composite video signal for display in time sequential format on a conventional television receiver display means, said apparatus comprising:

field identity detecting means for detecting respective odd and even fields in said first and second video signals;

field selecting means for alternately selecting fields from said first and second video signals in response to an output signal from said field identity detecting means, whereby, in use, a composite video signal containing said stereoscopic image pair in time sequential format can be produced; and,

control means for controlling an optical device, worn by a viewer of the television receiver display means, in response to a timing signal from said field selecting means, to provide stereoscopic viewing.

According to a still further aspect of the present invention there is provided a method of converting first and second video signals corresponding to the left and right eye image of a received stereoscopic image pair into a composite video signal for display in time sequential format on a conventional television receiver display means, said method comprising:

detecting respective odd and even fields in said first and second video signals;

alternately selecting fields from said first and second video signals whereby selected odd fields and/or selected even fields can be used to produce a composite video signal containing said stereoscopic image pair in time sequential format;

supplying said composite video signal to the display means of the television receiver; and

controlling an optical device worn by a viewer of the television receiver to control alternate viewing with the left and right eye of the left and right image respectively in such a manner as to provide stereoscopic viewing of the television receiver display means.

According to a final aspect of the invention there is provided a video camera for producing a composite video signal containing a stereoscopic image pair in time sequential format, comprising:

an image sensor;

a binocular lens system for focussing first and second images of a stereoscopic image pair onto said image sensor;

first and second optical shutter means arranged in the optical path of the respective first and second images, whereby the image reaching the image sensor can be alternated between said first and second images;

wherein, in use, an output signal of said image sensor can be synchronised so that the odd and even fields of the composite video signal correspond to the first and second images of the stereoscopic image pair.

Conventional television receivers can receive the television signal transmitted on the principal channel. Since the principal channel conforms to existing television standards, no modification to conventional receivers will be required. Special receivers can be designed to incorporate the auxiliary channel(s) and to display the additional information together with the principal channel or to display the principal channel only, thus maintaining compatibility with existing transmitters.

Brief Description of the Drawings

Preferred embodiments of the television transmitting and receiving system and method will now be described with reference to the accompanying drawings in which:

Figure 1 is a block diagram of a first embodiment of a television receiver circuit capable of providing stereoscopic image display;

Figure 2 illustrates a second embodiment of a circuit similar to that shown in Figure 1 but capable of providing enhanced resolution;

Figure 3 is a schematic diagram of a preferred embodiment of a field storage means employed in the circuit of Figure 2;

Figure 4 is a block diagram of a preferred embodiment of a circuit for converting a 3-D video signal into a 2-D video signal;

Figure 5 is a schematic diagram of a binocular lens system for generating a stereoscopic image pair;

Figure 6 illustrates schematically a method of displaying autostereoscopic images using a lenticular screen;

Figure 7 illustrates schematically the position of additional display points in a field line for increased horizontal display resolution;

Figure 8 illustrates schematically the position of additional display lines in a field for increased vertical display resolution;

Figure 9 is a schematic diagram of a display screen showing a preferred manner of dividing an image on the screen into sections;

Figure 10 is a block diagram of a preferred form of de-multiplexer circuit used for dividing an image as shown in Figure 8; and

Figure 11 is a block diagram of a preferred embodiment of a high resolution television receiver circuit.

Background in relation to Transmission and Reception of Stereoscopic Images

The impression of depth in vision is provided by the fact that our right eye and our left eye see slightly different images when viewing an object or scene. Numerous techniques and schemes have been proposed to provide correspondingly different television images to the left eye and right eye to emulate a three dimensional effect. Basically, these systems provide two slightly different images for each eye and some means of stopping one eye from seeing the image intended for the other. Known schemes make use of colour filters, electro-optical or electro-mechanical shutters, viewing pipes, polarized light and corresponding glasses, and multiple images displayed on a lenticular screen. All these schemes require the transmission and reception of two or more images.

Applying the preferred system of this invention to this application, the image of one eye (say, the left eye) is transmitted through (say) the principal channel according to conventional television broadcasting standards, and the image of the other eye (the right eye) is transmitted through the other channel, in this case through the auxiliary channel also according to conventional television broadcasting standards. During the blanking period, (when the unused lines are transmitted) identification signals such as left eye view odd field, or right eye view even field, and the like are inserted and transmitted to the receiver. The two broadcasting channels are preferably synchronised such that the blanking periods of the two channels coincide with each other. Assuming a complete frame is formed by first transmitting the odd field followed by the even field, the synchronisation mechanism between the two channels is also designed to ensure that the two channels are carrying complementary fields in the same time interval; i.e. when the principal channel is transmitting an odd field, the auxiliary channel is always transmitting an even field and vice versa.

A conventional television receiver can receive signals from either the principal channel or the auxiliary channel and obtain a normal 2-dimensional picture since both channels conform to conventional television standards. Advantageously, the principal channel may be located in the VHF band whilst the auxiliary channel may be located in the UHF band, thus giving viewers with conventional 2-D receivers the option of watching the same program on the channel which is clearest at their particular geographical location, whilst giving viewers with the receivers fitted with the 3-D capability the option of watching the program in stereoscopic image format.

Any of the conventional methods of displaying stereoscopic images by employing two different images for the left and right eyes can be used to display stereoscopic pictures by obtaining the view of each eye from the respective channel. The receiver can also be designed to ensure that

only the image from the principal channel is delivered to both the left and right eye if no signal is detected on the auxiliary channel, or if its identification signal indicates that it is not for stereoscopic viewing.

A low cost converter can be built to allow a conventional television receiver to be used for stereoscopic viewing at reduced vertical resolution, used in conjunction with an optical device worn by the viewer such as, for example, fast liquid crystal optical shutters.

Detailed Description of Preferred Embodiment

Figure 1 is a block diagram of a low cost converter circuit which enables an enhanced image in the form of a stereoscopic image pair to be displayed in time sequential format but at reduced resolution on a conventional television receiver while the viewer wears a pair of optical shutter lenses over his eyes. Video and audio baseband signals are extracted from the principal and auxiliary channels using known techniques in receiver circuits 1. A selector switch 2 selects one of the two audio signals. The field identity of the video signal from each channel is detected by a field identity detector circuit 3 which consists of circuit elements similar to those used to detect Teletext information. Field identity detector circuits 3 detect identification signals inserted at the transmitter in the blanking intervals of both channels. The video signals are then passed to a field selector circuit 4 which is controlled by the outputs from field identity detector circuits 3. The field selector circuit 4 alternately selects fields from the two channels for further processing. Since transmitted fields of the two synchronised channels are complementary to each other, field selector circuit 4 ensures that only the same fields (either always odd or always even) are chosen from respective channels. In other words, the composite video signal output of the selector circuit 4 will comprise fields of the same type but alternating left and right view. The other output of field selector circuit 4 is fed to optical shutter control

circuit 5 and indicates which optical shutter should be closed so that when the field for the left eye is passing through, the control circuit 5 will control the closing of the optical shutter of the right eye and the opening of the left shutter. For safety reasons, the optical shutters are normally open unless signalled to close.

If the field identity detector circuits 3 fail to detect valid identification signals in the incoming video signals, only the video signal from the principal channel will pass through, and the optical shutter control circuit 5 is disabled. The video signal from selector circuit 4 and the audio signal from selector switch 2 are then recombined in a modulator circuit 6 to a normal television broadcasting format and sent to the antenna input of the television receiver. The resultant image for each eye view in the stereoscopic image pair consists of one field only instead of a full frame, hence the vertical resolution is reduced. If the principal channel actually contains fields for alternate images of a stereoscopic image pair (for example if the output of modulator circuit 6 was recorded on a conventional video recorder and played back through the principal channel), optical shutter control circuit 5 will still be activated although the auxiliary channel is never selected.

A more complicated converter circuit is required to display stereoscopic images in full resolution.

Figure 2 is a block circuit diagram of a converter circuit capable of providing stereoscopic viewing with normal resolution. Receiver circuits 1, selector switch 2, field identity detector circuits 3 and optical shutter control circuit 5 operate exactly the same as described above in relation to Figure 1. However field selector circuit 4A provides separate outputs for both odd only and even only fields, an unmodified video signal from the principal channel to a video signal multiplexer circuit 10, a signal to a time base generator 9 for producing different line drawing speed and a timing signal to the optical shutter control circuit 5. The odd fields from field selector circuit 4A are passed to a

field storage means 7 and the even fields are passed to a line storage means 8. The outputs of field storage means 7 and line storage means 8 are also fed to the video signal multiplexer circuit 10 which produces a composite video output signal that is fed to a display means 11. Time base generator 9 controls the line scan rate of the display means 11.

Field storage means 7 is a storage device for storing one field. It may be implemented by digital memory devices or by an analogue storage device such as a charged coupled device. Digital field or frame storage are well established technologies and may be employed together with suitable digital/analogue and analogue/digital conversion. However, a charge coupled device (CCD) specially designed for this purpose may lower the cost of the implementation of the field storage means 7. The CCD field storage device can be considered as an array of shift registers. Each shift register contains a plurality of storage elements corresponding to points in a field line. There are a total n+1 such shift registers in the field storage means 7, where n is the number of lines in a field. Figure 3 shows a schematic diagram of such a field storage device.

An incoming signal is sampled and shifted in the input register 13 which consists of m storage elements 12 each holding enough information for a point of the incoming line. (Note that for colour television, three such elements are connected in parallel as a group to hold the information for the three primary colours). The signal is sampled at a rate corresponding to the required horizontal resolution of the display unit 11 such that input register 13 holds one complete line. The stored line is then shifted into the line storage area 14 after one line is captured (all elements in input register 13 are shifted one element upwards into line storage area 14 at the same time). The lines can be recovered by sequentially shifting out the contents of output register 15. The whole operation is clearer when considered together with line storage means 8, time base generator 9 and video signal

multiplexer 10. Line storage means 8 is similar to field storage means 7 except it does not contain a line storage area 14.

Time base generator 9 is a variable line scan time base generator which is controlled by modified field selector circuit 4A. If field selector circuit 4A confirms that the receiver is in stereoscopic mode, time base generator 9 will generate a line scan rate double that of the normal line scan rate, i.e. each line takes only approximately 32 microseconds to scan, in effect, producing a full frame in the time previously allowed for a field. The result is a doubling of the vertical resolution of a field. Video signal multiplexer 10 selects which input (an odd line, an even line or the unmodified principal channel) is to be fed to the display unit 11.

Let us start from the moment a new field is received from the auxiliary and the principal channel respectively. Since the fields are complementary, one of them is odd and the other is even. Let us assume the convention adopted is that an even field of a frame is sent after the corresponding odd field. At this moment, we have the odd field corresponding to the incoming even field from one channel already stored in the field storage means 7 with line number 1 sitting in output register 15 waiting to be shifted out. Input register 13 of field storage means 7, and the input and output shift registers of line storage means 8 are all empty. The time base generator 9 is set to generate line scan rate at double the normal speed of stereoscopic operation. The image associated with the incoming even field will be displayed during this field scan, hence shutter control circuit 5 will signal to close the optical shutter corresponding to the eye associated with the incoming odd field and open the other. The incoming first odd line (say line L1) is shifted into the input shift register 13 of field storage means 7. The incoming first even line (say line L2) of the other channel is shifted into the input shift register of line storage means 8. Time base generator 9 initiates the field and line scan after

half of the incoming line has been received (approximately 32 microseconds). The field timebase is the same as a normal television, at 20 msec or 16.67 msec. But the line timebase is double the normal rate, at approximately 32 microsecond. Accordingly, a full frame will be displayed in the time it normally takes to display one field.

The first line to be displayed is the first line of the odd field stored in output register 15. It is shifted out at twice the speed to match the increased line scan rate and passed through video signal multiplexer 10 to the display unit 11. At the same time as the first line of the stored odd field has been completely displayed on the screen, the first line of the incoming odd and even fields have also been completely captured in the respective input registers of storage means 7 and 8. During the line blanking interval, lines in field storage means 7 are shifted one line towards the output register 15, thus placing the second line of the stored odd field into output register 15, and the first line of the incoming stored odd field in input register 13 into the lowest line of line storage area 14 and vacating input register 13 for another new incoming line. At the same time, line storage means 8 shifts the content of its input register into its output register, vacating the input register for another new line. The output register of line storage means 8 then supplies the television display signal for the second line at double the incoming line speed to display unit 11 via multiplexer 10. After this line is displayed, the input shift registers of both storage means 7 and 8 are again half full. The output register of field storage means 7 then supplies the display signal of the third line (this is the second line in the initial odd field storage). By the end of the step of displaying this line, the input registers of storage means 7 and 8 are full again. The operation repeats itself for the rest of the lines in the field. By the end of this field period, the next odd field is stored in field storage means 7

while the full frame corresponding to the incoming even field is displayed on the screen. The whole procedure then repeats itself for the other view.

If field selector circuit 4A fails to detect the correct identification signals, it sets time base generator 9 to normal line timebase generation and passes the unmodified video signal of the principal channel to display unit 11 via multiplexer 10, effectively disabling storage means 7 and 8. The receiver then operates as a normal receiver.

Many domestic television receivers cannot display the full vertical resolution offered by the broadcasting stations due to their small screen size and finite size of the colour mask in the colour display tube. For example, the size of each coloured dot on a normal colour cathode ray tube is about 1 mm in diameter, a screen with aspect ratio of 4:3 and a diagonal length of 50 cm can only display approximately 300 separate lines. This level of resolution is approximately the same as the vertical resolution of a single field. A 3-D program of reduced resolution can be recorded on a conventional video cassette recorder (VCR) by recording alternating views of the left and right eye instead of the usual odd and even fields, similar identification tags are attached to the unused lines of the fields during the blanking interval as described above. During 3-D playback, the fields are displayed on the TV screen sequentially, and a field identification detector similar to field identity detector circuit 3 above controls the optical shutter control circuit 5.

During 2-D playback, only one of the views is displayed while the other is suppressed. A circuit for converting a 3-D video signal into a 2-D video signal is shown in Figure 4. Assume only the left eye view is shown as the 2-D view. When the identification detector 3 detects a field for left eye view, it signals the signal switch 24 to pass the video signal through directly to video output circuits. It also signals a field storage means 25 to store the current left eye view. Field storage means 25 is similar

to field storage means 7 except that there are more storage elements 12 in input register 13 and output register 15 such that it holds enough information for one complete video line in composite form, and both input and output are clocked at the same frequency. During the playback of the field for left eye view, the video signal is sent to the output circuits as well as stored in field storage means 25. During the playback of the field for right eye view, detector circuit 3 signals the switch 24 to block its direct video output signal while at the same time it signals field storage means 25 to send out its stored field after a half line delay. Hence the actual output to the TV receiver is always the left view resulting in a normal 2-D picture.

A 3-D recording can be generated by recording the reduced resolution composite video signal derived from a two channel transmitting system as described above. It can also be generated from a single video camera with a specially designed binocular lens system as shown in Figure 5, using an image sensor which is free of residual imaging for each field, such as a frame transfer CCD image sensor. The housing 28 provides optical paths for first and second images through the binocular lenses to reach the image sensor 27. Optical shutters 26, similar to those used for 3-D viewing, are placed in the optical paths to select the appropriate image reaching the image sensor. During recording, image sensor 27 is synchronised with the image pickup timing, such that the output fields of the video camera are alternating left and right images instead of odd and even fields of the same image. Corresponding identity tags are added to the output video signal and recorded on the VCR. The recorded composite video signal is identical to the format mentioned above in relation to the two channel transmission and reception of stereoscopic image pairs of reduced resolution.

Autostereoscopic television may be implemented by providing one principal channel and multiple auxiliary channels. In autostereoscopic television it is unnecessary for the viewer to wear special shutter lenses or polarizing

glasses. Instead the screen of the display means is provided with a special plastic layer, similar to that employed with the recently popular 3-D pictures, to form a lenticular surface. Multiple interlaced images are displayed on the screen and give the perception of depth to the viewer. Each image is transmitted over a separate channel. Figure 6 illustrates a lenticular screen 29 with interlaced images. Pxy is the yth picture element of the xth image forming the autostereoscopic image.

Application for High Resolution Television

With the recent advent of large screen projection television sets, the resolution offered by present television broadcasting standards has become inadequate. A new television standard which rivals the resolution of 35 mm movie films is proposed by some television manufacturers. This high definition television (HDTV) yields a television picture with over 1100 scanning lines (approximately double that of the current systems). Unfortunately, this standard is totally incompatible with the current broadcasting systems. Converting the signals of the new standard into a format suitable for existing receivers has been proved too expensive. The invented system solves this incompatibility problem by placing the extra information for high resolution display in the auxiliary channel or channels depending on the amount of extra information required to be transmitted. A normal television receiver only displays the signal in the principal channel as described in the stereoscopic application while the presently proposed high resolution television receiver incorporates the extra information transmitted in the auxiliary channel to form a high resolution image. Of course, the high resolution television receiver can still display the signal from the principal channel by itself, like a normal television set, when it is not operating in high resolution mode.

The vertical resolution of a frame is determined by the number of lines in the frame and the horizontal resolution is determined by the number of points along a line which is limited by the bandwidth of the signal. To increase the resolution of a frame, extra points are required in a line and extra scanning lines are required in a field or frame. Doubling the horizontal and vertical resolution requires 2 x 2 = 4 times the points in a frame. However, data compression techniques can be used to reduce the extended transmission requirement for this additional information. For example, let one line be formed by points p1, p2, p3,..., pm where m is the number of points in the line as illustrated in Figure 7. The points p1', p2', p3',...pm-1' are the additional points for higher horizontal resolution. In most circumstances, these additional points are either the same as one of their neighbours or an interpolation based on the neighbouring points because the original points are reasonably close to each other. Hence, one could list all the new points that are the same as their left neighbour, all the new points that are the same as their right neighbour and those points that do not appear on either of these lists are understood to be an interpolation of their two immediate neighbours. The receiver can reconstruct these extra points by interpolation from the original signals for p1, p2,..., pm and these lists.

A similar strategy can be employed for the extra lines as illustrated in Figure 8. Points in L1' and L2' can be characterized by their relationship to their upper and lower neighbouring lines L1 and L2, L2 and L3 respectively. The transmitter sends the starting relationship between an extra line and the original lines on either side thereof, for example, being the same as the upper line, and also the position at which a change in this relationship occurs (say to being the same as the lower line), and then the next position to change to, say, an interpolation of the upper and lower lines and so on. The receiver can then reconstruct the extra

lines based on the signals for the original lines L1, L2..., Ln and this additional information. The additional information is transmitted in the auxiliary channel.

Signals in the auxiliary channel do not need to comply with an existing standard since the compatibility lies in the principal channel. Assume a high resolution television transmission scheme in which an aspect ratio of 5:3 instead of the present 4:3 is required with double vertical and horizontal resolution. A transmission and reception system downward compatible with existing systems is described below using the data compression technique discussed above. Other methods of data compression can be used to obtain the additional information for the auxiliary channel provided the receiver is designed to reconstruct the high resolution image based on the chosen method.

The screen is divided into three sections as shown in Figure 9. The middle section 16 forms the base signal for the principal channel. The two side portions 17, 18 and the compressed data for higher horizontal and vertical resolution form the base signals for the auxiliary channel. The division may be performed by passing the line signal into a time controlled de-multiplexer as shown in Figure 10.

Referring to Figure 10, a time base generator 20 controls a demultiplexer 19. Storage elements 21, 22 and 23 are line storage devices similar to the shift registers described earlier. The first 10% of the line is sent to line storage device 21, the middle 80% is sent to line storage device 22 and the last 10% is sent to line storage device 23. Thus splitting the line into three complementary segments. Line storage device 21 and 23 could be combined in one device if desired provided some form of indication of their partition can be established. Information concerning the relationship of the additional points for the line, and the corresponding addition line (say the line immediately below it) is also calculated at the same time and transmitted to the user via the auxiliary channel.

Hence if a full frame is formed by lines L1, L1', L2, L2',..., Ln-1', Ln as shown in Figure 8 and each line is formed by points p1, p'1, p2, p2',..., Pm-1', Pm as shown in Figure 7, then the odd field of the principal channel consists of lines L1, L3, L5,... each consisting of points p(.1m+1), p(.1m+2), p(.1m+3),..., p(.9m) and the even field of the principal channel consists of lines L2, L4, L6,... each also consisting of points p(.1m+1), p(.1m+2), p(.1m+3),..., p(.9m). During the time when the principal channel is sending line L1, the auxiliary channel sends the two end sections, 17 and 18 in Figure 9, of the line, i.e. p1, p2, p3,..., p(.1m) and p(.9m+1), p(.9m+2), p(.9m+3),..., pm; the compressed data for p1', p2', p3',... for line L1 and the compressed data for line L1'. Similarly, when the principal channel is sending line L2, L3, L4,... the auxiliary channel is sending the corresponding end portions of the same line and the compressed data for the extra points in the line and the line that follows the sending line.

Note that the provision of identification signals in the field blanking intervals of the respective channels allow receivers designed for different capabilities to fall back on a picture of existing quality. Hence a receiver designed to display stereoscopic images may ignore the compressed information in the auxiliary channel and display the normal 2-dimensional image contained in the principal channel only.

Figure 11 illustrates schematically one embodiment of a HDTV receiver circuit according to this invention. The HDTV receiver circuit comprises first and second television signal receiving circuits 1 and 30 for detecting the signals on the principal channel and an auxiliary channel respectively. The baseband signals from the principal and the auxiliary channel are fed to storage devices 7 and 32 respectively. Field storage device 7 is identical to field storage means 7 described above with reference to Figure 3. A signal processing circuit 33 combines the incoming signals from receiving circuits 1 and 30 and the stored signals from storage devices 7 and 32 to form even and odd field lines of a

high definition composite video signal. The even and odd field lines are stored in a high definition field storage device 34 and line storage device 35 respectively. Selector switch 31c controls the sources of the respective field lines of the high resolution composite video signal. Selector switch 31a directs the video signal during the odd field from the principal channel to the field storage device 7. Selector switch 31b directs the video signal containing the compressed data from the auxiliary channel during the same period to the storage device 32. Each of selector switches 31a, 31b and 31c are controlled by an identification detecting circuit (not shown) which detects identification signals inserted in the field blanking intervals of the video signals.

A description of the operation performed by the illustrated embodiment of the receiver will now be given with reference to Figure 11.

During the period when the first odd field is detected by the receiver, each line of display is reconstructed from the signals obtained from the principal channel and the auxiliary channel and stored in the field storage device 7. The compressed data of L1', L3', L5',... are stored in storage device 30. At the end of this period, the field storage device 7 contains enough information to reproduce the odd lines L1, L3, L5,... of the central section 16 of the original frame in full horizontal resolution, and the second field storage device 30 contains the compressed data for L1', L3', L5'...

The timebase generator of the receiver (not shown) is again selectable between a normal mode with line timebase at approximately 64 microseconds, and a high resolution mode with line timebase at approximately 32 microseconds. The field timebase is unchanged at 20msec or 16.67 msec depending on the standard used.

During the period when the receiver is receiving the even field, the signals from the principal channel and the auxiliary channel respectively are both directed to the signal processing circuit 33 when they are combined to form even

lines L2, L4, L6,... at high horizontal resolution. During the same period when incoming even field video signals are being combined to form lines L2, L2', L4, L4',... the signal processing circuit 33 also combines the stored information in the field storage devices 7 and 32 to form lines L1, L1', L3, L3',.... Together, lines L1, L2, L3, L4, L5, L6, ... form the odd field of the high resolution frame, while lines L1', L2', L3', L4', L5', L6',... form the even field of the high resolution frame. A display operation, similar to the display of full resolution stereoscopic images in normal resolution described above, is adopted to display high resolution field lines L1, L2, L3,... within one field period. The display unit (not shown) starts to display L1 after half of L2 has been reconstructed. Since the displaying rate is twice that of the receiving rate, the receiver completes the reconstruction of L2 and the displaying of L1 at the same time. L2 is supplied to the display unit from the storage device 35 where it is temporarily stored while L4 is being reconstructed. The compressed data of L2' is received and stored in a temporary storage device within the processing circuit 33 during the reconstruction of L2.

The display unit then starts to display L2, and at the same time combines L1, L2 and the compressed data for L1' to reconstruct a displayable L1' which is then stored in field storage device 34. At the same time the processing circuit 33 is also reconstructing L4 from the incoming signals and saving the compressed data of L4' in a temporary storage device within the processing circuit 33. When the display unit completes the displaying of L2, processing circuit 33 will have reconstructed half of L4. The circuit then starts to display L3 which is stored in storage device 7, and by combining L2, L3 and the temporarily stored compressed data of L2', a displayable L2' is reconstructed and stored in the field storage device 34 following L1'. The whole process repeats itself until the end of the field. In effect, the receiver displays lines L1, L2, L3,..., Ln in high horizontal resolution during the time when the transmitter is sending the

even field of the principal channel. The solid lines in Figure 8 can be renumbered to correspond to the odd numbered lines of the high definition frame.

During the following odd field, the HDTV receiver circuit displays the reconstructed L1', L2', L3',... of the previous frame stored in the field storage device 34, while storing the incoming signals for L1, L3, L5 and the compressed data for L1', L3', L5',... for the new frame. The lines displayed during this period are equivalent to the even numbered lines of the high resolution frame. The overall display result when combined with the previous field period is a 2:1 interlaced frame with 5:3 aspect ratio at double the horizontal and vertical resolution of conventional television standards.

The division of the frame into three sections as described above to obtain the wide-screen aspect ratio of 5:3 is of course not essential to the invention. To obtain a high resolution picture with a standard aspect ratio of 4:3, the auxiliary channel would only carry compressed data to enable the reconstruction at the receiver of the additional points and lines for the normal resolution picture transmitted over the principal channel.

As with the transmission and reception of stereoscopic images over a principal channel and an auxiliary channel, the transmission and reception of high resolution images described above assumes that the convention adopted is that an even field of a frame is sent after the corresponding odd field. Consequently, it is the incoming odd field which is stored completely while the incoming even field is processed directly for display. However, the opposite convention may also be employed so that the odd field of a frame is sent after the corresponding even field. In this case, the method of the invention would involve storing the incoming even field while the incoming odd field is processed directly for display.

Transmission and reception of high resolution stereoscopic television while maintaining downward compatibility with conventional receivers and the above described invented system can be implemented by employing two principal channels and two corresponding auxiliary channels, one pair for the left eye view and the other pair for the right eye view.

In the description of the system and method of transmission and reception of stereoscopic image pairs it was assumed that the two channels carry complementary fields. However, this assumption was made in order to simplify the description of the method and apparatus of one embodiment of the invention. The invention is equally applicable when both channels transmit even and odd fields simultaneously.

It will be apparent to persons skilled in the electronics and television arts that numerous alterations and modifications can be made to the systems and method, other than those specifically described, without departing from the basic concepts of the invention. All such modifications and alterations are to be considered within the scope of the invention, the nature of which is to be determined from the foregoing description and the appended claims.

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. A television transmitting and receiving system for providing enhanced image display, the system comprising:

transmitting means for transmitting a first television signal over a principal channel and a second television signal over an auxiliary channel;

receiving means for receiving said first and said second television signals;

converting means for converting the received said first and said second television signals to obtain a composite video signal and for supplying said composite video signal to a display means; and,

wherein, in use, said principal channel conforms to conventional television standards and at least the first of said first and second television signals is compatible with conventional televisions receivers,

whereby enhanced image display can be obtained using information contained in the second television signal.

2. A method of transmitting and receiving television signals to provide an enhanced image for display comprising:

transmitting a first television signal via a principal channel;

transmitting a second television signal via an auxiliary channel;

said first television signal being a standard television signal which can be received and displayed by a compatible television receiver;

said second television signal containing additional information to provide the enhanced image;

receiving said first and said second television signals; and

providing an enhanced image display.

3. The method as claimed in Claim 2, further including converting said first and said second video signals to obtain a composite video signal and supplying said composite video signal to a display means whereby an enhanced image can be displayed.

4. The method as claimed in Claim 3, wherein said composite video signal is supplied to the display means to provide a stereoscopic image and wherein said first video signal contains information corresponding to one image of a stereoscopic image pair and said additional information in the second video signal corresponds to the other image of said stereoscopic image pair.

5. The method as claimed in Claim 4, wherein said step of transmitting further comprises inserting identification signals during the blanking intervals in both channels, wherein said identification signals include signals identifying odd and even fields of the respective first and second television signals.

6. The method as claimed in Claim 5, wherein said step of transmitting further comprises synchronising the blanking intervals of the first and second television signals in a complementary fashion whereby whenever the principal channel is carrying an odd field the auxiliary channel is carrying an even field and vice versa.

7. The method as claimed in Claim 6, wherein said step of converting comprises:

detecting said signals identifying odd and even fields of the respective first and second video signals; and

alternately selecting fields from said first and second video signals for producing a composite video signal containing said stereoscopic image pair in time sequential format.

8. The method as claimed in Claim 6, wherein said step of converting further comprises

storing one field of a current frame of said first video signal; and then

combining the incoming other field of the current frame of the first video signal with said stored field of the first video signal to produce one image of the stereoscopic image pair;

storing one field of the current frame of said second video signal simultaneously with the above step of combining; and then

combining the incoming other field of the current frame of the second video signal with said stored field of the second video signal to produce the other image of the stereoscopic image pair; and then

repeating each of the above steps for the next frame of the stereoscopic image pair.

9. The method as claimed in Claim 8, wherein said step of supplying the composite video signal to the display means involves supplying the frames of the composite video signal at twice the normal rate whereby a full frame at normal resolution can be displayed in the time it normally takes to display one field of a standard video signal.

10. The method as claimed in Claim 3, wherein said composite video signal is supplied to the display means to provide a high resolution image and wherein said first video signal contains information corresponding to an image of normal resolution and said additional information in the second video signal comprises compressed data for increasing the vertical and/or horizontal resolution to obtain said high resolution image.

11. The method as claimed in Claim 10, wherein said compressed data for increasing the vertical resolution comprises information for interpolating an additional line between each of the field lines of both the even and the odd fields of said normal resolution image, and said compressed data for increasing the horizontal resolution comprises information for interpolating an additional point between each of the points in the field lines of both the even and odd fields of said normal resolution image.

12. The method as claimed in Claim 11, wherein said step of transmitting includes dividing each frame to be transmitted into three sections, said first television signal containing information corresponding to a central section of a frame and

said additional information in the second television signal further comprising information corresponding to two side portions of the frame.

13. The method as claimed in Claim 12, wherein said normal resolution image is provided with an aspect ratio of 4:3 and said high resolution image is provided with an aspect ratio of 5:3.

14. The method as claimed in any one of Claims 10 to 13, wherein said step of converting comprises:

storing the incoming field lines corresponding to a first half of one field of the current frame of the high resolution image as well as the incoming compressed data corresponding to a first half of the other field of the current frame of the high resolution image; and then,

reconstructing said one field of the current frame of the high resolution image by combining the incoming field lines corresponding to the second half of said one field with the stored field lines of the first half of said one field; and simultaneously,

reconstructing and storing the other field of the current frame of the high resolution image by processing the stored compressed data and incoming compressed data corresponding to the second half of the other field of the current frame of the high resolution image; and

repeating each of the above steps for the next frame of the high resolution image.

15. The method as claimed in Claim 14, wherein said step of supplying the composite video signal to the display means involves supplying the frames of the composite video signal at twice the normal rate whereby a full frame of the high resolution image can be displayed in the time it normally takes to display one field of a standard video signal.

16. Apparatus for converting first and second video signals corresponding to the left and right eye image of a stereoscopic image pair into a composite video signal for display in time sequential format on a television receiver display means, said apparatus comprising:

field identity detecting means for detecting respective odd and even fields in said first and second video signals;

field selecting means for alternately selecting fields from said first and second video signals in response to an output signal from said field identity detecting means, whereby, in use, a composite video signal containing said stereoscopic image pair in time sequential format can be produced; and

for use with control means for controlling an optical device, worn by a viewer of the television receiver display means, in response to a timing signal from said field selecting means whereby to provide stereoscopic viewing.

17. Apparatus as claimed in Claim 16, further comprising means for selecting an audio signal corresponding to one of said first and second video signals and means for combining said selected audio signal with said composite video signal and modulating the resultant signal to a conventional television format for supply to the antenna input of a conventional television receiver.

18. Apparatus as claimed in Claim 16, wherein said field selecting means alternately selects fields from said first and second video signals and supplies only odd fields from both video signals to a first output, and only even fields from both video signals to a second output.

19. Apparatus as claimed in Claim 17, further comprising line storage means connected to one of said first or second outputs of the field selecting means for storing a line, and field storage means connected to the other of said first or second output for storing a field.

20. Apparatus as claimed in Claim 19, wherein said field storage means comprises an array of n+1 shift register means, where n is the number of lines in a field, said array having an input register means, a field storage area and an output register means.

21. Apparatus as claimed in Claim 20, wherein said line storage means comprises an input shift register means and an output shift register means.

22. Apparatus as claimed in Claim 20, wherein each of said shift register means has m storage elements, where m equals the number of points in a single field line corresponding to the required horizontal resolution of the display means.

23. Apparatus as claimed in any one of Claims 19 to 22, further comprising a variable line scan time base generator for generating a line scan rate double the normal line scan rate, and for generating a field scan rate at the normal rate.

24. Apparatus as claimed in Claim 23, further comprising a video signal multiplexing means connected to the output register means of said field storage means and said line storage means, for multiplexing respective even and odd field line signals from said output registers to obtain said composite video signal, wherein, in use, said even and odd field line signals are shifted out at twice the speed with which they entered the respective input registers in order to match the increased line scan rate.

25. A method of converting first and second video signals corresponding to the left and right eye image of a received stereoscopic image pair into a composite video signal for display in time sequential format on a television receiver display means, said method comprising:

detecting respective odd and even fields in said first and second video signals;

alternately selecting fields from said first and second video signals whereby selected odd fields and/or selected even fields can be used to produce a composite video signal containing said stereoscopic image pair in time sequential format;

supplying said composite video signal to the display means of the television receiver; and

controlling an optical device worn by a viewer of the television receiver to control alternate viewing with the left and right eye of the left and right image respectively in such a manner as to provide stereoscopic viewing of the television receiver display means.

26. A video camera for producing a composite video signal containing a stereoscopic image pair in time sequential format, comprising:

an image sensor;

a binocular lens system for focussing first and second images of a stereoscopic image pair onto said image sensor; and,

first and second optical shutter means arranged in the optical path of the respective first and second images, whereby the image reaching the image sensor can be alternated between said first and second images;

wherein, in use, an output signal of said image sensor can be synchronised so that odd and even fields of the composite video signal correspond to the first and second images of the stereoscopic image pair.

27. Television transmitter apparatus for performing the method of Claim 2, comprising first means for transmitting television signals over one channel and second means for transmitting television signals over a second channel, said first channel being a principal channel and said second channel being an auxiliary channel, at least one of the channels transmitting a standard televisions signal which can be received and displayed by a compatible television receiver, and wherein the other of the channels transmits a television signal containing additional information to permit an enhanced image to be displayed.

28. A television receiver for performing the method of Claim 2, comprising means for simultaneously receiving a first television signal channel and a second television signal channel, and means for combining the signals received by both channels whereby to provide an enhanced image display, said

first television signal being a standard television signal which can be received and displayed by a conventional television set but without the enhanced image.

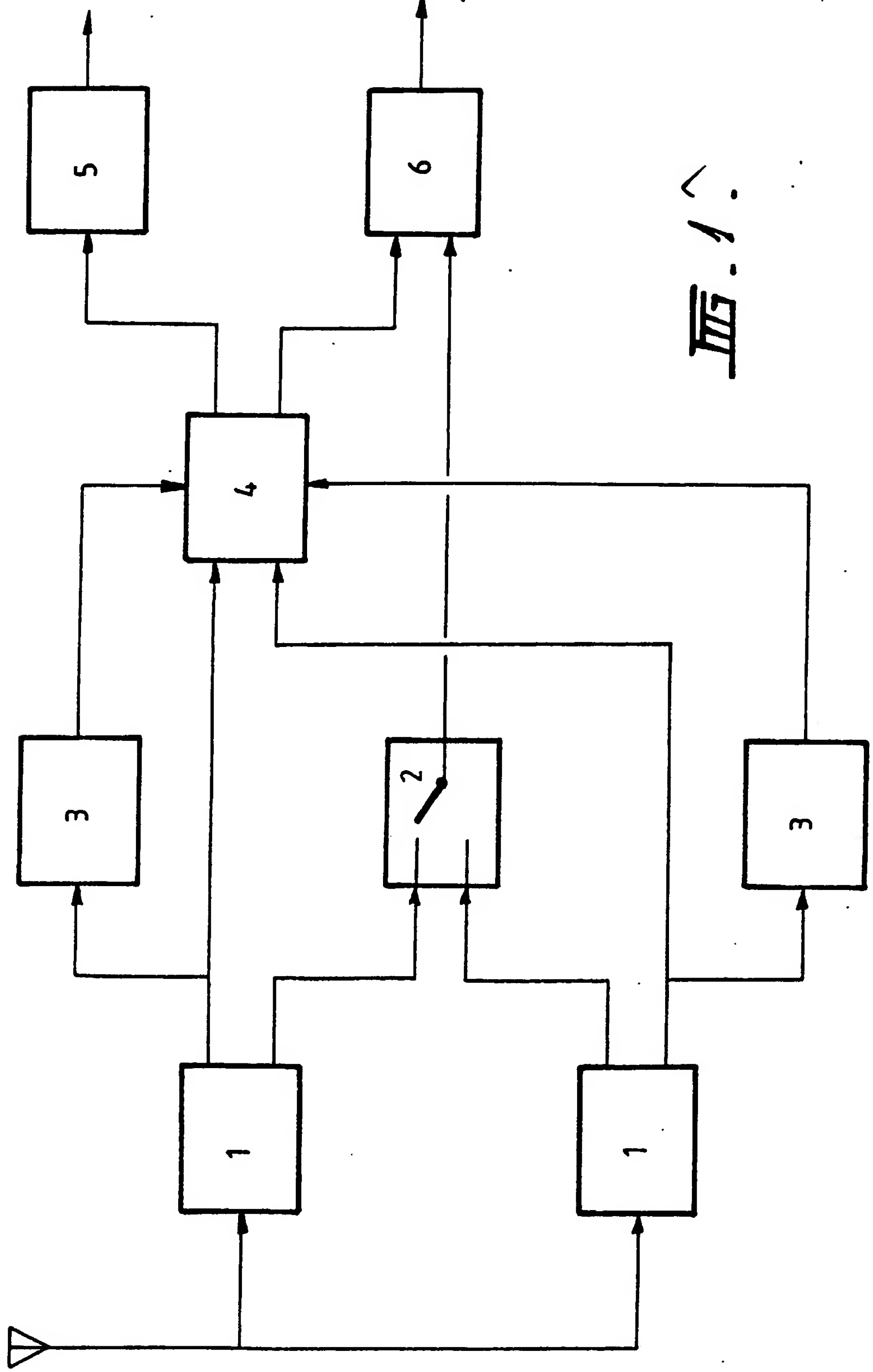

FIG. 1.

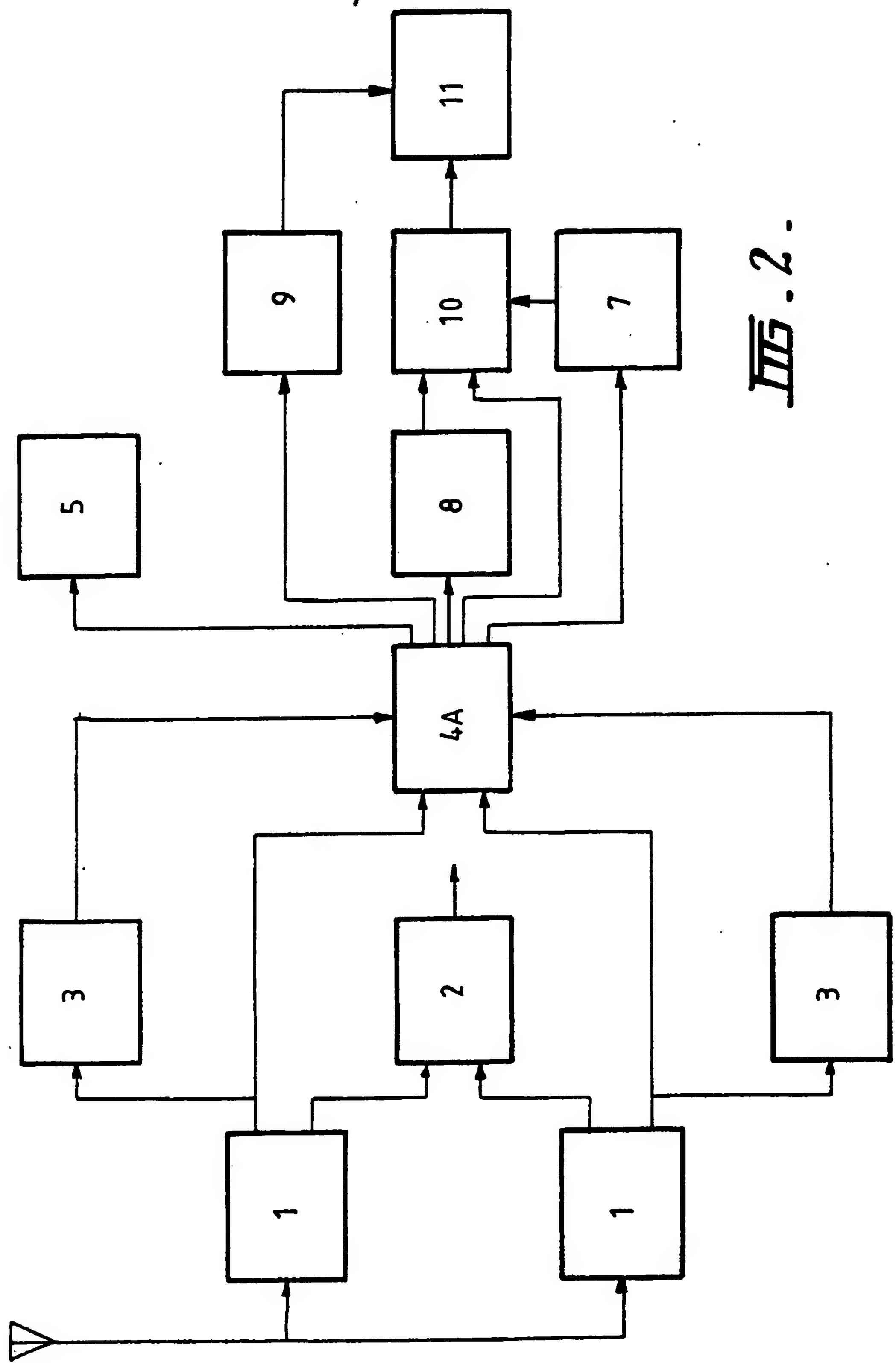

FIG. 2.

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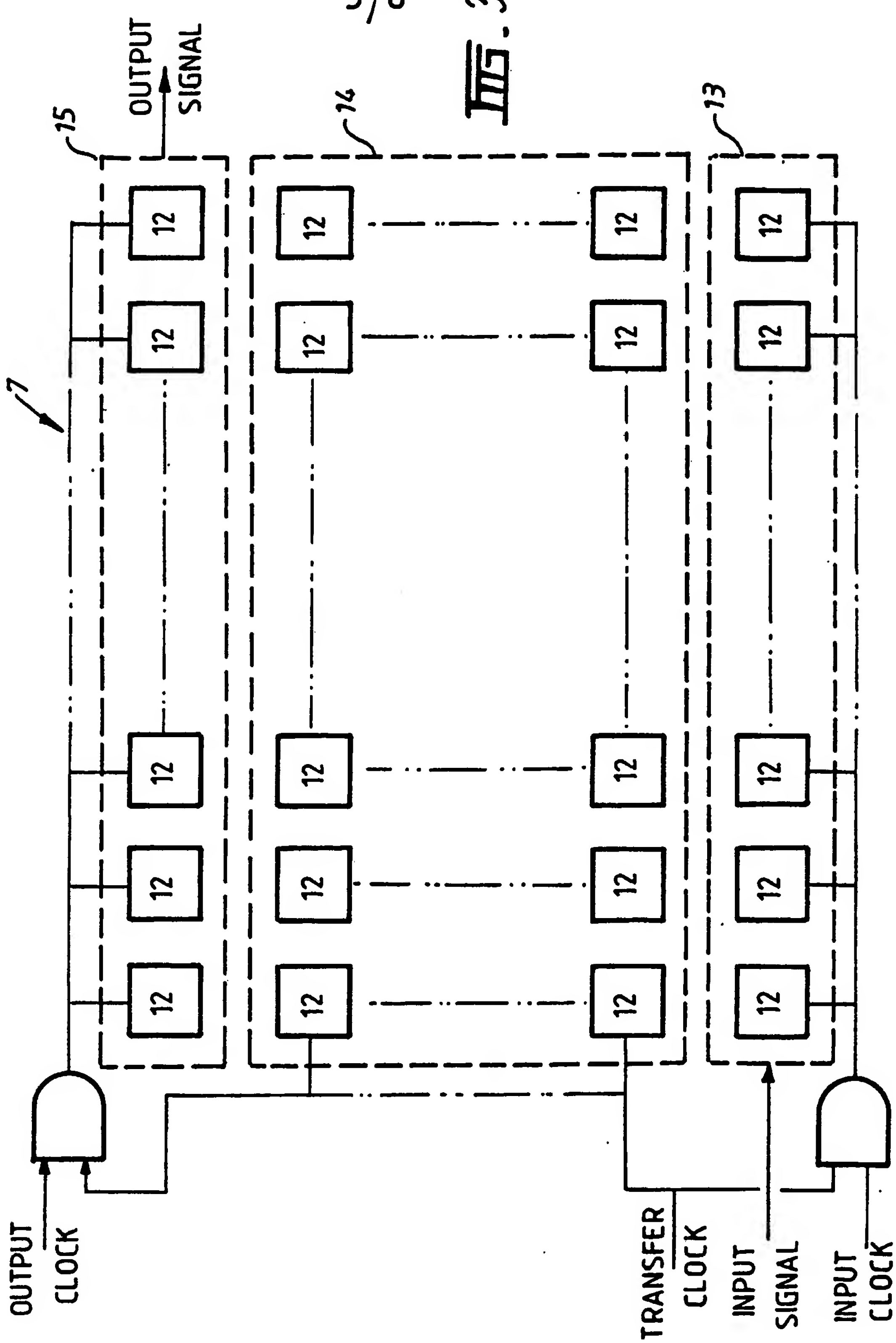
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14
13
7
12
OUTPUT CLOCK
TRANSFER CLOCK
INPUT SIGNAL
INPUT CLOCK

FIG. 3.

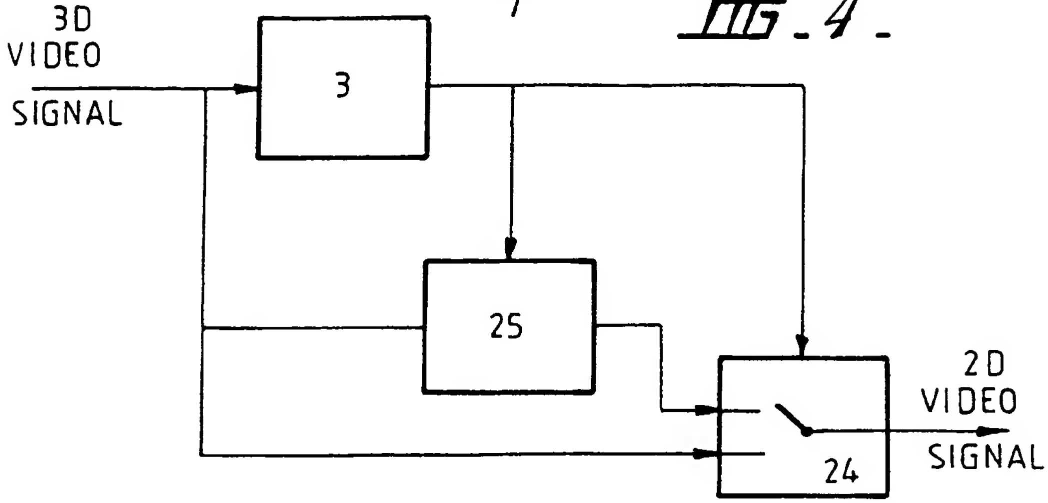

FIG. 4.

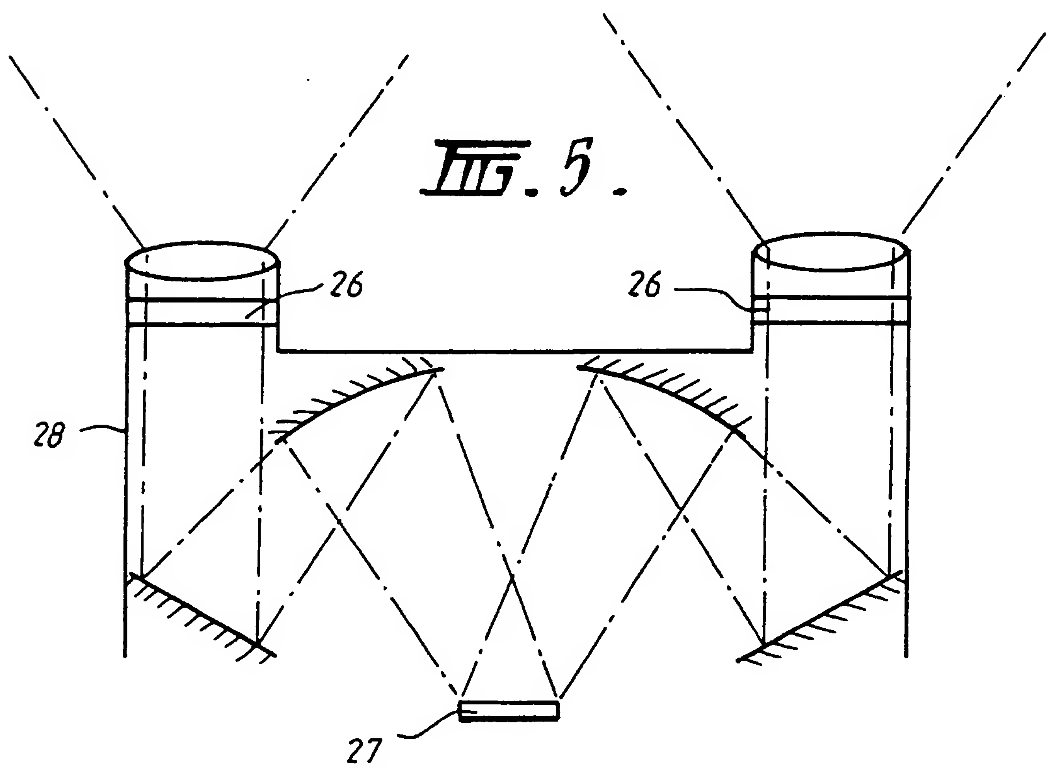

FIG. 5.

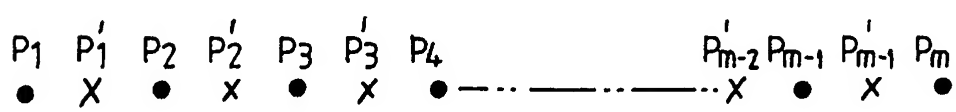

FIG. 7.

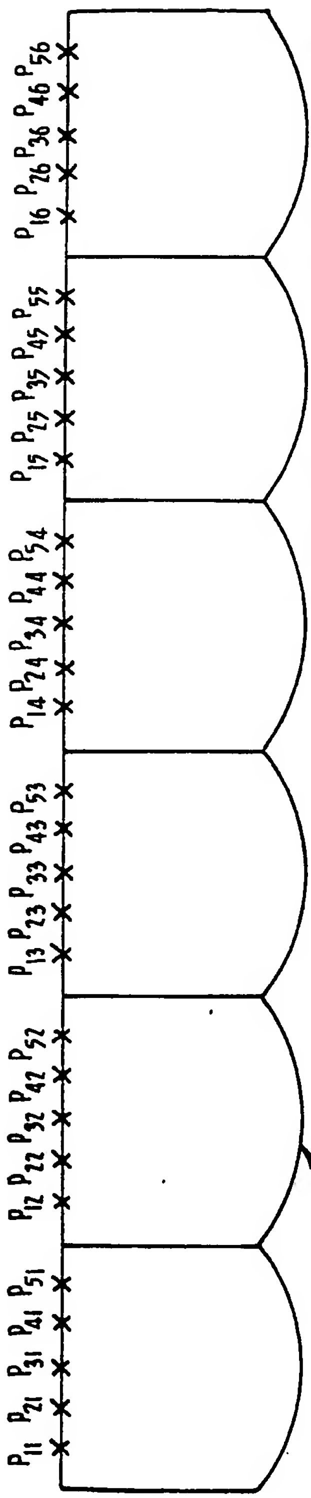

FIG. 6.

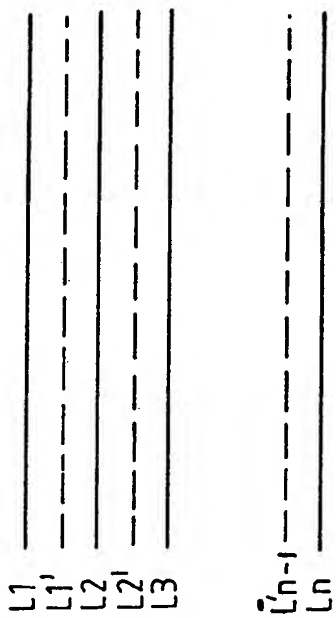

FIG. 8

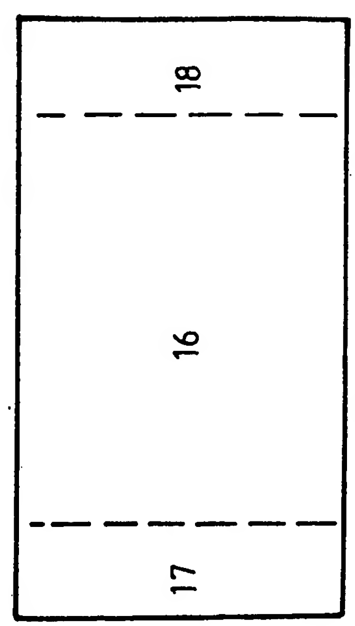

FIG. 9.

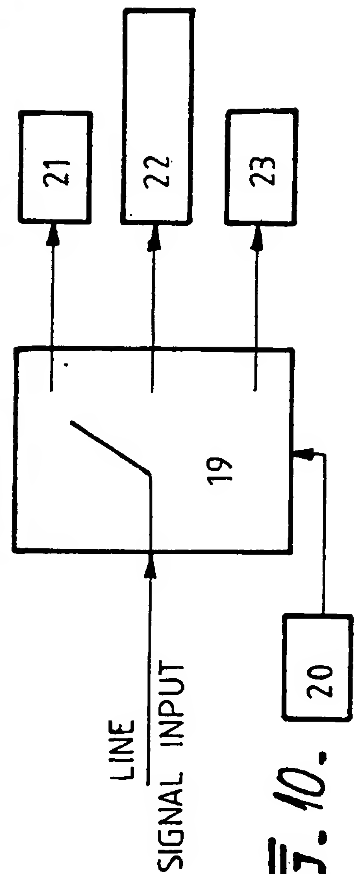

FIG. 10.

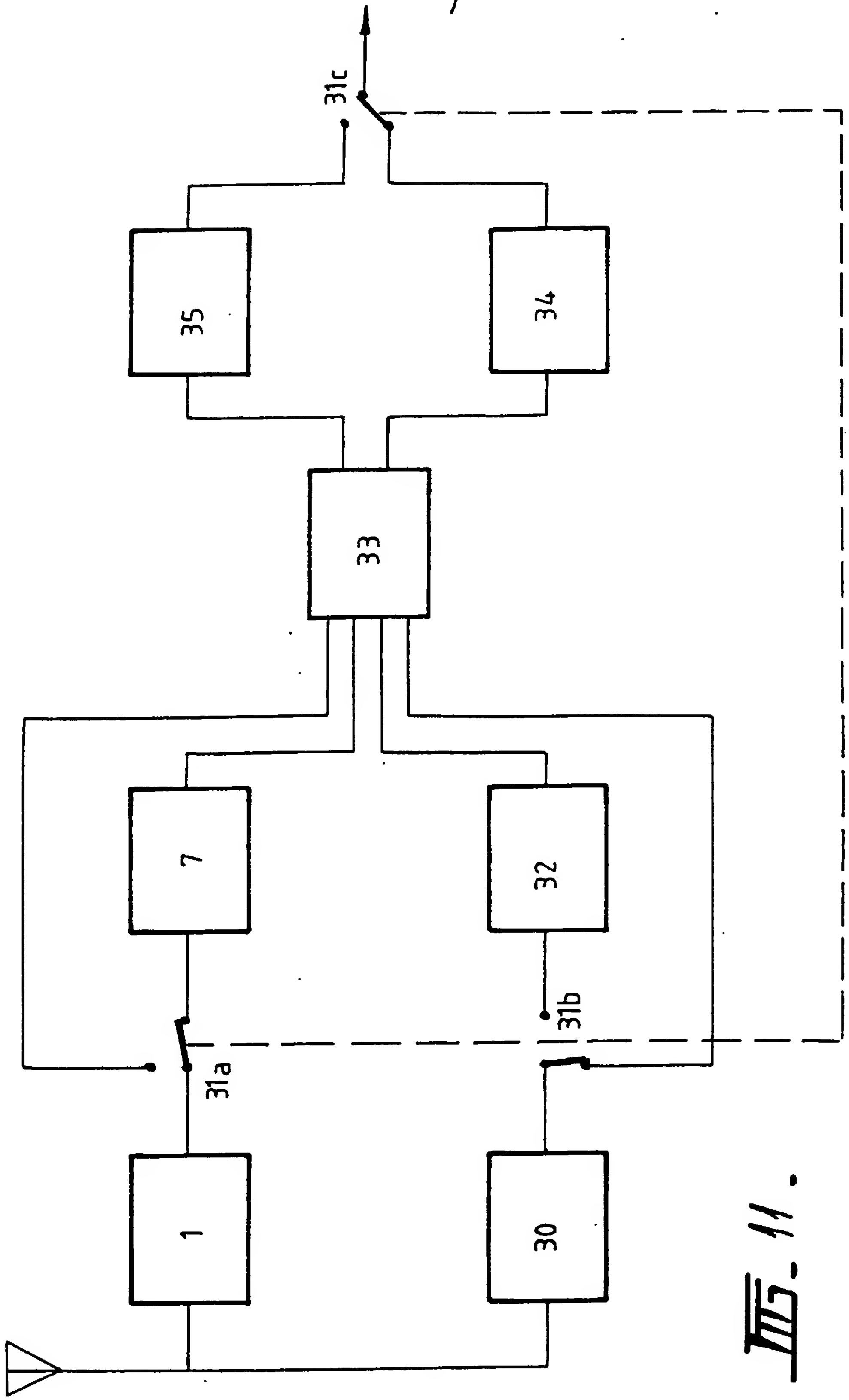

FIG. 11.

INTERNATIONAL SEARCH REPORT

International Application No PCT/AU 87/00273

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all)[3]

According to International Patent Classification (IPC) or to both National Classification and IPC

Int. Cl.^{4} H04N 7/08, 13/00, 13/02, 13/04

II. FIELDS SEARCHED

Minimum Documentation Searched[4]

Classification System	Classification Symbols
IPC	H04N 7/08, 13/00, 13/02, 13/04, 9/54, 9/56, 9/58

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched[5]

AU : IPC as above, Australian Classification 05.42

III. DOCUMENTS CONSIDERED TO BE RELEVANT[9]

Category[*]	Citation of Document,[11] with indication, where appropriate, of the relevant passages[12]	Relevant to Claim No.[13]
Y	US,A, 3725571 (JUSTICE) 3 April 1973 (03.04.73)	(1-8,10,27,28)
Y	US,A, 4387396 (TANAKA et al) 7 June 1983 (07.06.83)	(16,18,25)
Y	US,A, 4027333 (KAISER et al) 31 May 1977 (31.05.77)	(16,18,19,25)
X	US,A, 3842196 (LOUGHLIN) 15 October 1974 (15.10.74)	(1-3,27,28)
X	US,A, 3838444 (LOUGHLIN et al) 24 September 1974 (24.09.74)	(1-3,27,28)
X	US,A, 3821466 (ROESE) 28 June 1974 (28.06.74)	(16,18,25,26)
A	US,A, 4567513 (IMSAND) 28 January 1986 (28.01.86)	(1-7,16,18,25, 27,28)
A	DE,A, 1522286 (TELEFUNKEN) 7 August 1969 (07.08.69)	(26)

* Special categories of cited documents:[10]

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"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
6 November 1987 (06.11.87)	(19.11.87) 19 NOVEMBER 1987
International Searching Authority	**Signature of Authorized Officer**
Australian Patent Office	R. TOLHURST

Form PCT/ISA/210 (second sheet) (January 1985)

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON
INTERNATIONAL APPLICATION NO. PCT/AU 87/00273

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report	Patent Family Members		
US 3725571	BE 785112 ES 403638	CA 953412 FR 2143213	DE 2230348 GB 1381789
US 4387396	JP 57037977		
US 4027333	DE 2655872 JP 52082015	FR 2335114	GB 1508408
US 3842196	AU 58550/73 DE 2354257 IT 998968	CA 972458 FR 2204932 JP 49078429	CA 972864 GB 1384970
US 3838444	AU 58551/73 FR 2204933 JP 49075217	CA 992196 GB 1382406	DE 2354197 IT 1007552
US 4567513	US 4647965		

END OF ANNEX